

the males are able to discriminate between the sexes (via visual or short distance chemical communication) resulting in longer interplay and frequently to a successful union.

I believe that the initiation of mating sequences on the canopy is common among overwintering monarch butterflies and that it has been overlooked by earlier investigators. Once observed, it can be recognized easily; I examined and noticed this mating activity on a kodachrome slide I took in the winter of 1990–1991 and recently, in a picture of Mexican monarch butterflies on roosting trees published with a article in Natural History (Larsen, T. 1993. Nat. His., (6): 30–39). The capture of mates in flight, at least for California overwintering monarch butterfly populations, may not be as frequent as those initiated at the canopy level. I observed only one in-flight capture of a female by a male during many hours of field observations. This single event was observed when the female slowed her flight while trying to land on foliage, and was then captured by a male. The capture of stationary “mates” concentrated in a small area (foliage of roosting trees), after months of overwintering, saves time and energy, and provides maximum opportunities for mating.

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Scientific Note

OBSERVATIONS OF THE FORAGING PATTERNS OF *ANDRENA (DIANDRENA) BLENNOSPERMATIS* THORP (HYMENOPTERA: ANDRENIDAE)

Pollinator foraging movements can determine pollen transfer among flowers and thus may affect pollen and gene flow within and among plant populations (Handel, S. N. 1983. pp. 163–211. *In* Real, L. (ed.). Pollination biology. Academic Press Inc.). From a landscape perspective, pollinator foraging patterns form a spatial link among available floral resources that is bounded by the particular species' flight and floral preferences. Foraging studies that emphasize the latter can also help identify the spatial requirements of insect pollinators. Therefore, quantification of pollinator foraging patterns can yield information pertinent to floral ecology and evolution as well as to landscape utilization by insect pollinators. Unfortunately, many insect pollinator foraging patterns are not well documented, and that is especially true for solitary bee species.

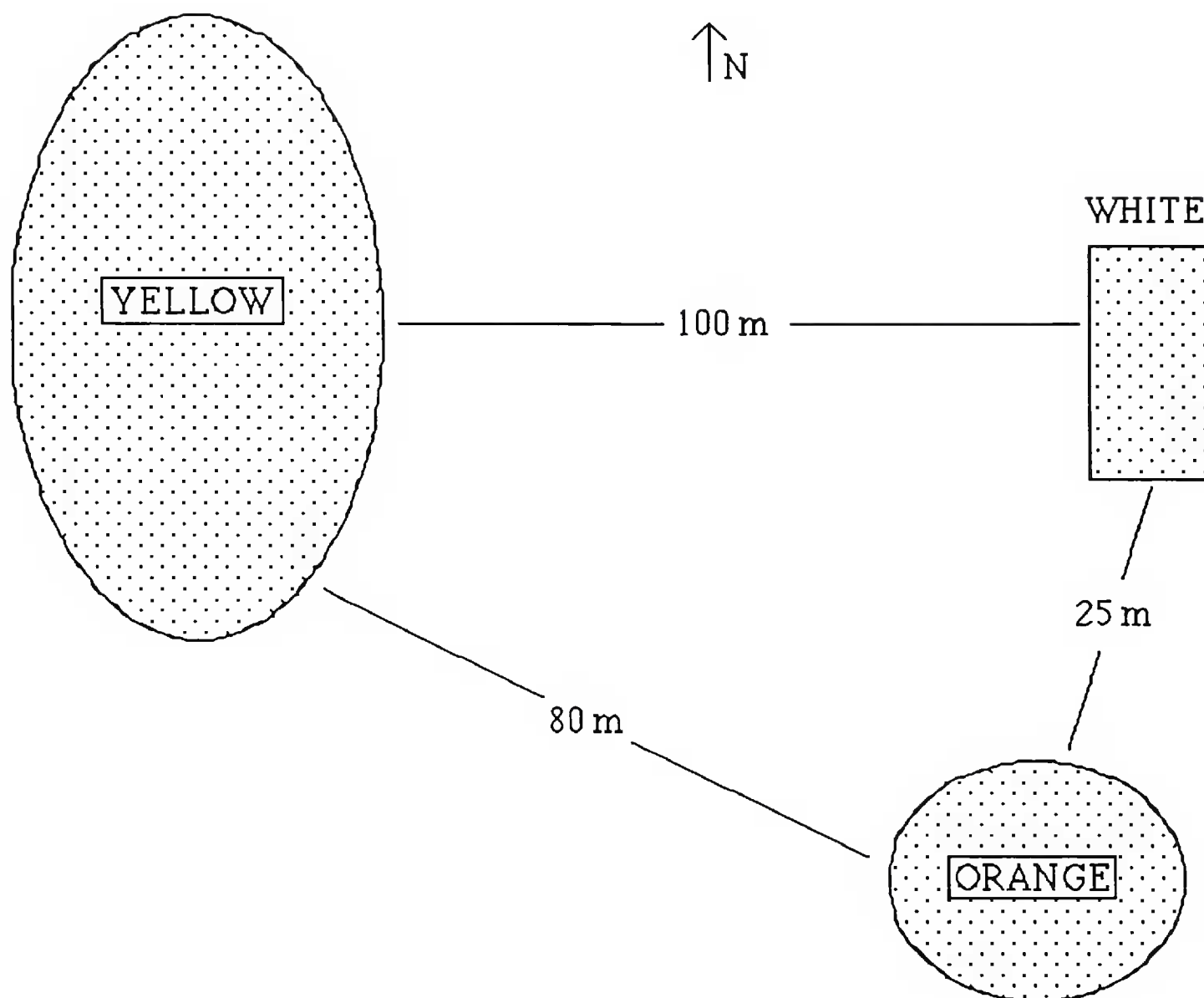


Figure 1. Schematic diagram of *Blennosperma nanum nanum* patches observed. The approximate shapes of patches, and distances between patches are as indicated. The approximate sizes of the white, orange, and yellow patches are 54 m², 560 m², and 960 m², respectively.

We studied the foraging patterns of the native, solitary bee *Andrena* (*Diandrena*) *blennospermatis* Thorp, which is oligolectic on *Blennosperma nanum nanum* (Hook.) Blake, a vernal pool plant (Thorp, R. W. 1969. Univ. Calif. Publ. Entomol., 52: 1–146). Specifically, we sought to determine whether individual females of *A. blennospermatis* forage between discrete patches of *B. n. nanum*. Our primary purpose was to evaluate the spatial utilization of discrete floral patches by female *A. blennospermatis* during one flight season. Consequently, in this study, we are interested in the spatial, rather than temporal, patterns of female *A. blennospermatis* foraging.

We conducted this study at Jepson Prairie Preserve, near Dixon, Solano Co., California from 6–18 Mar 1993. This period encompassed the peak of the adult flight season of this bee in 1993. To observe interpatch foraging, we marked and subsequently observed marked female bees in three separate patches of *B. n. nanum* (Fig. 1) on each of nine nonconsecutive days (March 6–8, 10–11, 13–14, 16, 18) between 10:00–13:00 h. However, the period of time we spent marking and observing each day varied to some degree, depending upon weather conditions and flight activity. Except for the first date, one person marked and observed bees

in all patches on each day. On the first date, a total of six people simultaneously marked and observed bees, two per floral patch. The number of bees marked per patch per date varied (1–11 bees) yielding a total of 64 marked bees.

We marked female bees by placing a dot of enamel paint on the thorax using a plastic dental toothpick. Each floral patch was assigned a unique color: white, yellow, or orange. Female bees netted within a floral patch were marked with that patch's color and immediately released. To assess the extent of interpatch foraging by *A. blennospermatis* females, we recorded observations of foraging females in which the female's color was different from the assigned patch color. Because we were concerned with the spatial patterns of floral utilization, rather than the temporal aspects of those foraging patterns, we kept each patch color constant throughout the study. This system of marking, however, did not allow us to distinguish individuals marked the same color unless they were sighted simultaneously. Voucher specimens are deposited in the Bohart Museum, University of California, Davis.

Our observations indicate that limited interpatch foraging by female *A. blennospermatis* occurs. Of 28 females marked in the white patch, only 2 (7%) were observed foraging simultaneously in the orange patch (Fig. 1). Of 25 females marked in the orange patch, only 1 (4%) was observed foraging in the white patch. None of the 11 females marked in the yellow patch were observed foraging in the other two patches. These observations suggest that individual females occasionally forage between *B. n. nanum* patches 25 m apart (Fig. 1), but rarely forage, if at all, between patches 80–100 m apart. In contrast, we commonly observed intrapatch foraging by females that we were able to visually follow directly after marking. We cannot determine whether these instances of interpatch foraging represent movements within a single foraging bout, within a single day, or between days.

It is unclear how the floral patches (Fig. 1) are spatially related to the nest sites of the marked *A. blennospermatis* females. Although there were several areas near the white and orange patches that contained scattered nests of *A. blennospermatis*, *Andrena* (*Tylandrena*) sp. and other *Andrena* spp., we did not identify the individual nests of the marked females. However, we did identify the nests of two *A. blennospermatis* females whom we later individually marked. We observed one bee foraging in the orange patch that was approximately 50 m away from her nest. We observed the other female foraging at *B. n. nanum* patches 25 m or closer to her nest.

Our observations of limited interpatch foraging and common intrapatch foraging by *A. blennospermatis* females are consistent with other studies of andrenid bee foraging behavior. These studies (Danforth, B. N. 1989. *J. Kansas Entomol. Soc.*, 62: 59–79; Thorp 1969, 1990. pp. 109–122. *In* Ikeda, D. H. and R. A. Schlising (eds.). *Vernal pool plants—their habitat and biology. Studies from the Herbarium No. 8, California State University, Chico.*) suggest that the foraging areas of several andrenid bee species are spatially very limited. Thorp (1990) found that at Jepson Prairie Preserve, most females of *Andrena* (*Hesperandrena*) *limnanthidis* exhibited limited foraging areas and were observed 10 m or closer to the original marking site. Our observations suggest that *A. blennospermatis* females tend to forage within a particular *B. n. nanum* patch. Consequently, it is likely that females largely transfer pollen within a *B. n. nanum* patch rather than between patches (Fig. 1). Because *A. blennospermatis* females are one of the most common

visitors to *B. n. nanum* flowers (Thorp 1969, 1990), they may have the potential to strongly influence pollen flow within *B. n. nanum* patches.

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Scientific Note

LONG-TERM CHANGES IN *OBSCURA* GROUP *DROSOPHILA* SPECIES COMPOSITION AT MATHER, CALIFORNIA¹

Since the 1940s, Dobzhansky and his collaborators have collected *obscura* group *Drosophila* species from Mather, California, located at 1375 m on the western slope of the Sierra Nevada. Mather's Transition Zone association and moderate climate have made it one of the most heavily-collected areas in the world for *Drosophila*. Fifty years of accumulated data give us the rare opportunity to study long-term changes in *Drosophila* species' relative abundances. Such studies can also identify effects of climatic changes on species frequencies. This study documents evolution in *obscura* group *Drosophila* species composition at Mather, shows that the changes are associated with climate, and provides a baseline for future investigations.

The genetics of the *D. obscura* group have been studied extensively, but their ecology is largely unknown. The ranges of the four native California species vary latitudinally and altitudinally. In zones of geographic overlap, *Drosophila pseudoobscura* Frolova and *D. azteca* Sturtevant & Dobzhansky are more frequent in warmer and drier areas and at lower altitudes (Dobzhansky, T. & J. Powell. 1975. pp. 537–587. In R. King (ed.). *Invertebrates of genetic interest*. Plenum Press, New York.). *Drosophila persimilis* Dobzhansky & Epling and *D. miranda* Dobzhansky predominate at higher elevations and northern latitudes. Based on their zoogeography, *D. azteca* and *D. pseudoobscura* are perceived as the more dry/hot adapted of the four species.

Dobzhansky (1973. *Evolution*, 27: 565–575) noted an increase in the frequency of *D. persimilis* relative to *D. pseudoobscura* at Mather. Figure 1A shows this trend, supplemented with data from later collections by the persons mentioned in the acknowledgment. However, such relative abundances can be deceptive when the rest of the species group is ignored. Figure 1B shows the frequencies of

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